

Van Lennep (W^m B.)

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BY

WM. B. VAN LENNEP, A.M., M.D.,

PHILADELPHIA, PA.

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STUDIES IN INTESTINAL SURGERY.

BY WM. B. VAN LENNEP, A.M., M.D., PHILADELPHIA, PA.

A NUMBER of months ago, while waiting for a set of Senn's bone plates, I was called to do a herniotomy. The bowel was gangrenous and evidently from the jejunum, which precluded the formation of an artificial anus for fear of death from marasmus; the distended proximal end could not be invaginated into its collapsed distal fellow.* Fortunately the excellent condition of the patient allowed me the time necessary to unite the ends by a carefully applied Czerny-Lembert suture.

I was then impressed, as doubtless every one has been who has done the operation, with two things:

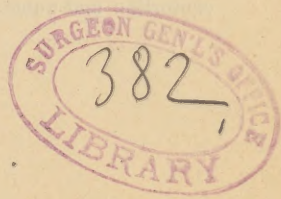
1. The ideal appearance of an end-to-end union as the nearest approach to a restoration of the normal condition.
2. The imperative necessity for a method to accomplish the same union in a much shorter space of time.

Enterorrhaphy by the Czerny-Lembert suture is apt to be followed by separation, the large number of sutures causing gangrene of the edge; or any one of these sutures, even in skilful hands, may perforate all the coats of the bowel and cause leakage. As might be pre-supposed, the mortality following this method is at best a high one, the figures given by different authors varying according to the character of the operation, the lesion calling for it and the condition of the patient from 48 per cent. (Reichel) to even as high as 100 per cent. (Weir).

In marked contrast with these figures are those of Senn and Jessett:† While enterorrhaphy with the Czerny-Lembert suture gave a mortality of $71\frac{5}{10}$ ths per cent., and this on healthy dogs, it was cut down to $7\frac{6}{10}$ ths per cent. in their experiments with the bone plates. True, the great majority of these experiments were not made to bring

* Senn's *Modification of Jobert's Method; Intestinal Surgery*, Chicago, 1889, p. 168; Also *Annals of Surgery*, vol. i., 1888.

† *British Medical Journal*, July 27, 1889.



about union after resection, but to exclude portions of the intestine from the digestive current, "physiological exclusion."

I very naturally determined to make a series of experiments with the following ends in view :

1. To familiarize myself with these methods ;
2. To find, if possible, a readily available, if only an emergency substitute for the substances used by Senn and others ;
3. To devise some means of end-to-end union that could be quickly applied and would do away with the disadvantages of the invagination method.

I will not burden you with the detailed account of every experiment, but describe the typical ones and those bearing directly on or leading up to the particular subject of this paper, making but a casual reference to others. The subjects were all dogs and in no instance was there any preliminary or after attention to diet, the animal being freely fed on bones, meat, vegetables, etc. There was furthermore no medicinal treatment beyond an opiate immediately after the operation to allay pain. The abdomen was shaved, scrubbed with soap and washed with bichloride solution. Distilled or boiled water, Thiersch's or salt solutions were used for the sponges and carbolized water for the instruments. Irrigation was dispensed with, the abdominal wound being packed with iodoform gauze during the operation on the intestine. Ether was the anæsthetic and chloroform was used to kill the animals.

I have here a number of specimens, removed post-mortem, which show very well the results obtained ; also samples of the different substances recommended for intestinal anastomosis and several drawings illustrating recent methods of intestinal union, together with those proposed and described in this paper. The latter were executed by my student, Mr. Arshagouni, to whom my thanks are due.

LATERAL ANASTOMOSIS. *

Experiment.—Small mongrel bitch. After a median laparotomy, six inches of the first presenting loop of small intestine were resected; the mesentery tied off in sections, and the openings closed and turned in by two rows of continuous silk suture. The two ends were crossed so as to look in opposite directions and a slit about an inch and a half in length was made on the convex surface of each. Into these openings a pair of Senn's decalcified bone plates were introduced and the corresponding threads tied together. A few linen sutures were added to fortify the weak points. The intestine was replaced after careful disinfection and the abdomen closed. The dog got along nicely and was killed two weeks later. There was firm union of the apposed surfaces and an opening that readily admitted the little finger. From its upper border hung the tangled silk threads in which were caught a mass of hair. There were a great deal of contortion and numerous adhesions. In the two *culs de sac* were found hair

and partly digested food, the remnants of a bone plate being in the upper one. The intestine above the anastomosis was very much distended, the cause being an acute flexion of the bowel from an adhesion to the lower blind end.

Experiment.—Small black and tan bitch. Six inches were again resected. The edges at each end were seized by a pair of toothed forceps, turned in and closed by a continuous suture of linen. Otherwise the details were the same as in the last, except that Abbè's catgut rings were substituted for the bone plates. Numerous adhesions and considerable contortion were again found at the autopsy, and the upper *cul de sac* was packed full of hair and food, the lower one being empty. Union was firm. Distension was present as in the former case, but due this time to the rings themselves. Prepared according to Abbè's directions,* ten days beforehand, they had undergone no change at the end of fourteen days beyond swelling and softening. The two lower and two lateral threads of silk had cut through, making deep notches, while the rings, twisted into a figure eight, hung from the two upper threads, forming, with the aid of hair and food, a complete dam.

Obstruction was found in both these dogs, and yet they apparently got along very well, except that the second one refused food and drink before she was killed. Senn considers this the reason why vomiting and tympanitis are moderate or absent in dogs.

While Abbè in his first communication † described a ring that can be made at an operation, in his second paper‡ he advises that they be kept some days in alcohol. In one instance much valuable time is lost in preparing them, and in the other as much is required as would be necessary to make, or at least to get, Senn's plates. It is reasonable to suppose, too, that it would take longer to digest these rings in the human intestine, hence a greater likelihood that the accident met with in this experiment would recur.

To obviate such a delay, I determined to try rings that could be quickly made, and would be available to any surgeon at any time or place. Nothing seemed better than rubber drainage tubing, which is found in every operator's bag.

These are made as follows: A *soft* piece of drainage tubing is taken (No. 16 Charrière is the size I have used most) and cut long enough to wind around two or more fingers, according to the size required. The ends are then united, forming a ring, by a stitch or two of catgut. Six strands of the same catgut, each eight inches long and each armed with its needle, are tied to the ring at equal distances. If there is time, it may be well to tie the knot on the side away from that to be used for apposition; the catgut is then wound around the tubing and the needle pushed through from the knot. As the catgut softens quickly, this is not a necessary precaution, and was only used in one instance.

* *Medical News*, June 1, 1889.

† *New York Medical Journal*, March 23, 1889.

‡ *Loc. cit.*

Experiment.—Mongrel puppy. Three inches were resected, and, in order to have a firm, unyielding substance, as nearly as possible like a bone plate, pieces of heavy, stiff Nelaton catheter (No. 17 Charrière) were used to make the rings. One ring, opened into a straight tube by absorption of the catgut, was passed five days later. The autopsy on the twelfth day, showed the same adhesions and contortion, but no obstruction or distension, the dog having had no untoward symptoms. The opening freely admitted the finger, and there was again an accumulation of hair and food in the upper *cul de sac*, in which lay the upper ring, now opened into a straight tube.

Experiment.—Small black puppy. Soft drainage tubing was substituted for the stiff piece of catheter, and prepared in the manner already described. As a precaution, a thread of linen was made to loosely unite an end of each piece of tubing, so as to guide the upper one down through the anastomotic opening. The whole seat of operation was covered with a large omental flap. The two pieces of tubing were passed on the fifth day. On opening the abdomen on the eighth day, the adhesions were found to be less than in previous cases. Union was firm, and the opening fully as large as the bowel lumen. There was an enterolith which filled the upper *cul de sac*.

One thing rather surprised me, namely, that in every experiment there was more or less accumulation in the upper blind end. This is contrary to the observations of Senn. From the condition found in the case in which the stiff piece of catheter was used, I am inclined to think that the direction of the digestive current is first down towards the bottom of the pocket, then around and back to and through the anastomotic opening. The tubing lay in the long axis of the intestine on the side away from the aperture, one end opposite to, and extending a little above, the latter, while the other was pressed so hard against the bottom of the pocket that it threatened to ulcerate through. Again, from the fact that there was some accumulation in the lower *cul de sac*, which was emphasized in the case with obstruction below the anastomosis, it would appear that the current took a similar course in the latter. This tortuous current may account, too, for the twisting and contortion. Possibly this is only the case when anastomosis is made after resections with the formation of these pockets, and they may not occur in the ideal object of lateral anastomosis, viz.: physiological exclusion of portions of the intestinal tract. After insisting on the advantage of exclusion over resection in certain cases, Senn says* that "peristaltic or antiperistaltic action" forces the contents out of these excluded portions. In such a short pocket this "action" cannot, of necessity, be very strong. In one experiment I produced an obstruction with a strip of iodoform gauze tied around the bowel, and made an anastomosis at some distance from it. There was but very little hair in the upper tube. As these accumulations are largely made up of hair, it is reasonable to sup-

* *Op. cit.* p. 54.

pose that they will not be met with in practice; but, nevertheless, the pockets can become pitfalls for undigested substances and foreign bodies.

The linen thread, to unite an end of each piece of tubing, was applied as a precautionary measure, and to insure the passage of the upper one. The reason the piece of catheter did not pass was probably its stiffness, which prevented its bending and accommodating itself to the digestive current above mentioned. The same was the case with Senn's plates, a well-formed remnant being found in the upper pocket at the end of two weeks. The *soft* tubing obviates this difficulty, as I found in one experiment in which the ends were not united by a thread. Senn and others have used substances for apposition which were passed, being indigestible or partly digested. In every instance, however, these were small pieces, or soft enough to adapt themselves to the tortuous current.

Hence, if Senn's plates are not at hand, or in fact in any case, the surgeon has a good substitute in rings quickly made from a piece of soft rubber drainage tubing. As the two rings are firmly held together by the six ligatures, their lack of stiffness appears to be no disadvantage, union being equally good when rings or plates were used. C. B. Penrose* has devised some very ingenious disks that can be cut out of sheet rubber after the pattern of Senn's plates. They are armed with strands of silk, held in place by catgut. They are fully as flexible as the soft drainage tubing rings, and gave very satisfactory results, being readily passed. The rings can be made in a shorter time, and the material for them is always at hand.

The results of the experiments also do away with the objection made to rings, that they do not hold large enough surfaces of the intestines together. Their pliability and the elastic pressure they exercise seem, theoretically at least, most desirable.

The small size of the opening after the use of Senn's plates in Abbé's case of colo-colostomy † tends to restrict their use, at least as they are at present prepared, to the small intestine. Connell's suggestion ‡ to use segments of the cartilage from the scapula of a young steer, which can be readily cut down to any size, may obviate this difficulty to a certain degree. The rubber rings, on the other hand, can be made of any size and thickness, and can therefore be adapted to any portion of the intestine. What is more, they can be made to suit the conditions found at the operation, without any loss of time.

* *Medical News*, June 1, 1889.

† *New York Medical Journal*, loc. cit.

‡ *Medical News*, May 4, 1889.

The only possible drawback to the rubber rings would be in multiple anastomoses, when some might be arrested in the pockets farther down. With soft, adaptable rubber rings, united with a thread of unabsorbable material, I have found, experimentally, that two pairs of rings can be passed.

The advantage of the rings of tubing over those of catgut, in my hands, is that they will not twist up and form a dam if some of the threads cut through before the rings are absorbed. Probably by substituting catgut strands for those of silk this could be obviated, as the ring, if undigested, would soon be released by their absorption. An experiment to be mentioned later on supports this view. Besides, by the rubber ring experiments it was conclusively shown that the catgut strands held long enough to enable firm union to take place. J. D. S. Davis, in a case of ileo-colostomy, found firm adhesions fourteen hours after the operation.* Furthermore, he states that his catgut mats absorbed in from forty to seventy hours in his experiments, showing that adhesions must be safe in this time at least. With these mats I have no experience beyond making them, but as he claims that an hour is necessary to prepare them, they are hardly available in an emergency.

I might say, just here, that I have experimented with other substances, notably substituting chicken-bone drains for those of rubber, but as they, too, are not in every instrument bag on all occasions, I will but briefly describe their use:

Experiment.—Large, grayish black mongrel. After a resection, anastomosis was made by chicken-bone rings. These were taken from alcohol and thoroughly softened in water; they were wrapped around two fingers, the ends made to overlap and tied together with silk. They were then armed with six strands of catgut, and used just as the rubber rings. Union was fortified by a continuous fine linen suture. No graft was applied. The result was similar to that found in the others, matting, twisting and adhesions to the line of union and the blind ends. There was no distension and no accumulation in the *culs de sac*. This was explained on opening the bowel; the upper pocket, which had been made deep purposely, was shut off by an acute flexion, produced by twisting and adhesion, just beyond the anastomotic opening. The lower one was so shallow that the teat encroached upon the opening, but evidently not enough to cause obstruction.

In experiments, such as I have described, *i.e.*, lateral anastomosis, the great drawbacks are the resulting adhesions and the twisting and contortion. These are especially marked when this method is used after resections. The adhesions are much diminished, if not entirely prevented, by the omental flaps suggested by Senn. As he says,

* *Virginia Medical Monthly*, September, 1889.

however, an omental flap has its obvious objections, and he proposes omental grafts for them. These grafts do not always "take," as occurred to him in at least one instance, and it is reasonable to suppose that this would be the more probable in a graft large enough to cover such an extensive surface as an anastomosis and its blind ends, for it is to these ends that I have invariably found adjoining loops of intestine adherent. Even should a graft be applied to each of these spots, time is lost and the chances of a failure trebled.

Hence, while lateral anastomosis is the ideal operation when it is necessary to unite portions of intestines above and below obstructions, etc., it is a question whether it is *the* method to be followed after resections of the gut. An end-to-end union does away with the contortion, as it produces the normal straight digestive current instead of a devious one that doubles on itself at least once. It obviates, too, the formation of the pockets which may give rise to accumulation; it has fewer points for adhesions, and requires a much smaller and but one graft, therefore one that is more likely to "take;" one, also, that can be obtained from the excised mesentery, as suggested by Weir, when the omentum is not accessible. Besides, the graft can be readily and accurately adjusted around this tube and linear wound. Furthermore, judging from the published reports and conversations with men well versed in abdominal surgery, the tendency of the profession generally seems to be toward the ideal end-to-end union, even since the publication of Senn's experiments. That author himself advocates such a union, and proposes his modification of Jobert's method. The drawbacks to this are first, disinvagination, which occurred in Senn's and probably in Jessett's experiments. Second, if both lumina are of equal size, the distal may be invaginated into the proximal end, a mistake that may readily occur (Senn and Jessett), and is followed by fatal results. Third, if, as I found, invagination is by no means easy when the ends are equal size, what insuperable difficulties there must be to an attempt to introduce an enormously distended proximal end into its collapsed and contracted fellow. Fourth, the narrowing of the lumen must of necessity be considerable when two whole thicknesses of the bowel and a sheet of rubber encroach upon it, and, in fact, in two out of fifteen experiments (Senn, Jessett) there was an accumulation behind the invagination, and consequent obstruction. Fifth, the statistics of these two experimenters give a mortality of $24\frac{9}{10}$ ths per cent. for invagination with an omental flap, and 75 per cent. without this protection, a rate higher than that of enterorrhaphy, as contrasted

with $7\frac{6.9}{100}$ ths per cent. for lateral anastomosis with plates. I know of but one case in which this method has been practiced.* Twelve inches of intestine were resected during an ovariectomy, and the ends united by invagination. The patient died of peritonitis on the tenth day, due to ulceration along a suture. The rubber lining was still in its place, and formed an obstructing valve by its free edge.

END-TO-END UNION BY MEANS OF RUBBER SPLINTS.

While attempting to force a proximal end, lined with rubber and made too large, into the distal end, it occurred to me to apply the principle used in anastomosis by drainage tube rings, to obtain an end-to-end union. They are made exactly as those already described, except that soft tubing of a smaller size is substituted, No. 8 to No. 10 Charrière, and but four strands of catgut, armed with needles, are tied to each. The size of the bowel is ascertained by introducing the finger into the opening, and the tubing cut to the requisite length. In one experiment it was found that a ring could be made in less than three minutes. The manner of their application is described in the experiments.

Experiment.—Medium-sized mongrel dog. A median laparotomy was made, and an inch resected from the first presenting loop of small intestine. The rings were made of pieces of a stiff Nelaton catheter (No. 6 Charrière); one was introduced into each end, and the four needles pushed through all the coats of the bowel at one-quarter inch or more from the free edge, two on each side of the mesentery, and two at equidistant points on the other side of the gut. The triangle, left uncovered by peritonæum at the mesenteric attachment, was carefully closed with fine catgut (Senn), the artery having been previously tied. The other end was similarly treated, and the two then drawn together. The corresponding strands of catgut from the rings were tied, and a continuous suture run around to prevent eversion, and unite the edges of the mesentery. The gut was disinfected and replaced, and the abdomen closed, layer by layer. The after-course was uneventful, the dog eating well, and the stools being formed. The rings were passed on the fifth day.

Autopsy, on the thirteenth day. Resection midway between stomach and ileo-cæcal junction. No distension or contortion, and but moderate adhesions. Union complete and very firm; the opening admitted the little finger, and was certainly more than one-half the size of the bowel above and below (the limit set by Senn). An adhesion to the mesentery caused moderate flexion of an adjoining loop, and, on breaking this up, a linen stitch was exposed.

Two changes were made after this experiment: (1.) Instead of introducing the needles one-quarter of an inch or more from the free edge, they were passed about one-eighth inch from it. The union was equally good, and the resulting constriction barely perceptible, as shown in some of the specimens. (2.) Soft rubber drainage tubing

* Jessett, *loc. cit.*

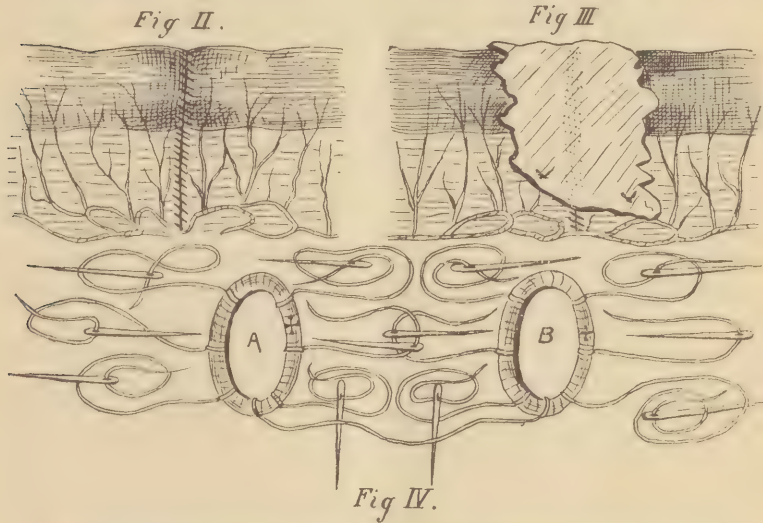
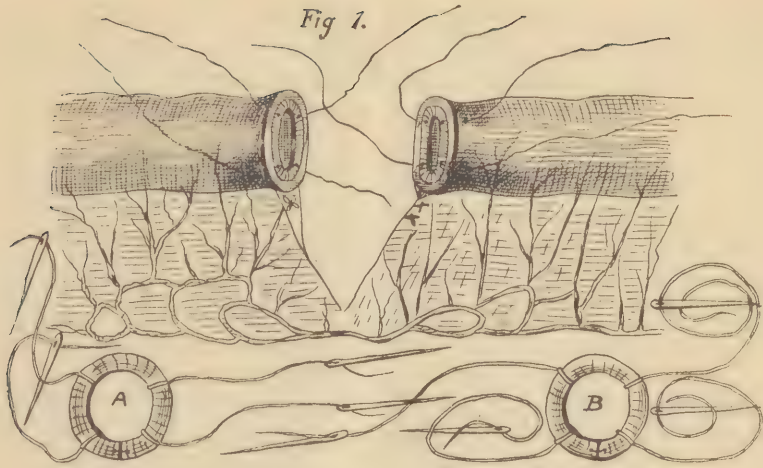


Fig. I. represents the rings in place ; on the left the artery tied, on the right the triangle exposed by the diverging layers of the mesentery united. A and B are the rings made of soft drainage tubing and armed each with needles and strands of catgut.

At Fig. II. the ends have been drawn together and a fine continuous suture of catgut applied to the line of union and the edges of the mesentery. Fig. III. shows the operation completed by a graft.

Fig. IV., A and B, are the rubber drainage tube rings for lateral anastomosis, while at C they have opened into two straight tubes united by a strand of silk by absorption of the catgut.

was substituted for the catheter, one end of which, inaccurately united to its fellow in the foregoing experiment, pressed so hard against the intestinal wall as to cause me considerable anxiety. It did no harm, however.

Experiment.—Large, black bitch, found to be pregnant on opening the abdomen. The presenting loop was cut across, and the end united, as in the last experiment, with rings made of No. 10 Charrière, soft drainage tubing. The line of incision was protected by an omental flap. The dog appeared perfectly well, eating freely, and passing formed stools, until killed at the end of a month. Fetuses had disappeared; no rings in the intestines, date of passage not being known. There was one adhesion of a loop of bowel to a stitch in the mesentery not covered by the flap. No distension, digestion being at its height. Union was perfect, and the constriction barely perceptible.

The details given of this experiment will save repetition in two others, which were perfectly successful; one in the small intestine, and one in the descending colon. An omental flap was used in one, a graft from the mesentery in the other. Both adhered, and their protective influence is undoubted. In another similar experiment, the abdominal wall having been united by a Zesas suture of catgut, the stitches gave way on the fourth day, the dog tore open the wound, and was found with complete protrusion of the bowels. Chloroform was at once administered, and the autopsy showed the rings *in situ*, the catgut absorbed excepting two strands which were quite soft. Union was very firm.

The nearest approach to this method of union, so far as I am aware, is the old Denans double invagination. A hard ring is introduced into each opening, and the edges turned in over it. The two ends are then pushed over a third smaller ring, and united by sutures. Neuber has since modified this by substituting rings of decalcified bone. The principle of the operation differs radically from the one I have proposed.

A reference to two other experiments may not be out of place here.

Experiment.—Large black mongrel cur. Eight or ten turns of catgut were made around the finger, and armed with four strands of the same material. They were then used like the rubber rings. No flap or graft was applied. The dog did not get along well, and was killed on the seventh day. There were large stitch abscesses in the abdominal wound, its inner surface being adherent to numerous loops of intestine, including the portion operated upon. In the mesentery of the latter was a leakage abscess, from which the continuous linen suture led into the bowel to one side of the line of union. One stitch had perforated all the coats and produced the leakage! The line of union was perfect and firm and the lumen but very slightly encroached upon, as can be seen from the specimen.

This experiment goes to prove that union will take place with the

softest kind of rings, provided they are held firmly together. The leakage emphasizes the danger of silk sutures as used in circular enterorrhaphy, for any of the numerous stitches may perforate all the coats and allow the bowel contents to escape. A continuous suture of the same material is also undesirable, as it puckers the intestines and tends to work its way into the bowel. (S. D. Gross.)

It is necessary, however, to suture the edges of the mesentery, turn in the pointing points, and fortify the line of union on the bowel. In order to save time this should be done by a continuous suture. I therefore substituted catgut in my later experiments, which, besides preventing leakage by swelling should it perforate all the coats of the bowel, certainly holds the edges together long enough to allow plastic exudation to seal and glue them. In this it is aided by the elastic splints inside, against which the continuous suture can be drawn tightly without puckering or constricting the bowel, while by the time the rings are loosened the outside suture is disorganized. In one experiment I purposely perforated all the coats of the bowel with two stitches. Leakage took place, but as the catgut swelled up it ceased. The bowel was disinfected and replaced, and no harm resulted.

It is a well-known fact that the weak point in all circular enterorrhaphies is the mesenteric attachment. In my earlier experiments I took no precautions to prevent leakage here, in order to find out how much the rings could do unaided. In operating on the human intestine it may be better to carry out the precautions used in the later experiments. The vessel is ligated and triangle closed as described. The mucosa is then united at the mesenteric attachment by one or two interrupted sutures of catgut. The edges of the closed mesentery are drawn together immediately underneath the bowel by a couple of stitches, and a Lembert suture applied on either side. A continuous stitch of catgut is then quickly run around the bowel and down the slit in the mesentery. A graft from the omentum or the excised mesentery completes the operation. By scarifying the surface to be grafted adhesion is aided and hastened. (Senn.)

Another experiment was made to try a substitute for flaps and grafts in case they cannot be obtained.

Experiment.—The small intestine was cut across and united, end to end, by means of rubber rings. A few interrupted sutures of linen were added to turn in pointing spots, the whole wound painted with iodoform collodion, and the bowel replaced. The dog showed no untoward symptoms, ate everything, and had formed stools.

Autopsy, two weeks later: Omentum adherent to abdominal wound; no adhesions to gut or to the collodion, which is beginning to peel off in spots. On picking it all off there was no plastic exudate underneath, and consequently no

union. The rings were in place, but, as the uniting strands of catgut had absorbed, the ends of the intestine were only held together by the collodion and a couple of interrupted stitches. In marked contrast with this was the portion next to the mesenteric attachment, which the collodion did not touch; here the union was very firm.

This shows that the rings cause no disturbance, the stiff splint of collodion on the outside having probably prevented sufficient peristalsis to dislodge them. It proves, too, that the digestive functions go on perfectly well while the rings are in place.

I am led to mention this experiment particularly on account of an excerpt I have since seen.* R. Stern recommends the use of collodion with iodoform to prevent abdominal adhesions to raw surfaces. The result certainly shows that adhesions do not form, and that iodoform collodion is in no sense irritating to the peritonæum, but that it also prevents plastic sealing underneath. It is, of course, a question whether, in the more sensitive human peritonæum, it would be equally harmless.

Here, then, was a rapid and safe method of uniting the resected ends of intestine, and it remained but to prove it by a suitable case. This was not long forthcoming.

STRANGULATED LEFT-SIDED FEMORAL HERNIA. HERNIOTOMY AND RESECTION OF TWELVE INCHES OF INTESTINE FOR GANGRENE. CIRCULAR ENTERORRHAPHY BY MEANS OF RUBBER DRAINAGE-TUBE RINGS. RECOVERY.

On August 10, 1889, Mrs. M., aged 35 years, was admitted to my service at the Hahnemann Hospital, suffering from left-sided strangulated hernia. She had always enjoyed excellent health, had borne seven children, and was nursing a babe eighteen months old. Two months previously a lump had appeared in the left groin while washing; this had suddenly become painful forty-eight hours before admission. Epigastric pains supervened, as well as vomiting, which later took on a fecal odor. There was obstinate constipation and no flatus was passed. She had been seen the evening before by Dr. Chas. D. Smedley, of Wayne, Pa., who diagnosed hernia, and, after failing to reduce it by careful and well directed taxis, brought her to the city for operation. When seen by me she had a pinched, collapsed look; the abdomen was distended and tender; the temperature 99° and the pulse 140, small and thready. In the left groin was an ovoid swelling, divided into two sections just below Poupart's ligament; it was boggy, tender and slightly reddened. The parts were prepared in the usual manner and the strictest antiseptic precautions observed throughout, bichloride, 1 to 2000, being used until the abdomen was opened, when Thiersch's solution was substituted.

An incision was made in the long axis of the tumor and the sac, which was of a dark bluish color, almost immediately reached. On opening this there came a gush of stinking fluid and a loop of dark, red and black, mottled gut presented. It was dull, soft and undoubtedly gangrenous. It was incised and found full of a putrid fluid. The constriction, at the junction of the falciform

* *Centralblatt für Chirurgie*, No. 33, August 17, 1889.

fascia and Gimbernat's ligament, was very tight and would not admit the tip of the finger. It was carefully incised under the guidance of the eye, a fortunate precaution, as a good sized vessel spurted, which was easily taken up and tied. The grooves made by the constriction in the gut were deep and in one or two spots had practically ulcerated through. The loop was well drawn down and cut across about an inch beyond the distal groove, the abdominal opening having been previously packed with iodoform gauze. The upper constriction in the gut was so tight that the gangrenous tube could not be used as a conduit to carry the contents well away from the opening. The bowel was accordingly resected about an inch above the upper groove and a V-shaped piece, which was also gangrenous, removed from the mesentery. A quantity of dark stinking fluid poured out, the bowel being cleansed and emptied farther by irrigation and kneading the abdomen. The gut above the resection seemed dull and dark, showing that the gangrene was of the spreading variety, so common, so deceptive and so fatal in intestinal strangulation. Four inches more were accordingly removed (making twelve inches in all) when the proximal end appeared perfectly healthy and like its distal fellow.

The question now came up how the gut should be treated. A Czerny-Lembert enterorrhaphy was out of the question on account of the condition of the patient, which was bad, hence should I establish an artificial anus with its inconveniences, the danger of marasmus and, taken altogether, its high rate of mortality; or should I quickly apply the method of union that had given me such excellent experimental results. My colleague, Dr. Betts, who was present, kindly gave me his endorsement for the latter course, and I proceeded at once to carry out the union end-to-end with rings of soft drainage tubing. Further leakage was prevented by the fingers of an assistant. The rings were made exactly as in the experiments, the size being determined by introducing the finger into the distal end and stretching it. By this time the proximal portion had contracted to such a degree that this stretching made them of nearly equal size. The two layers of the mesentery were carefully drawn together under the bowel and the catgut strands passed through the intestinal walls about one-eighth of an inch from the edge, one on each side of the mesentery and the other two at corresponding points opposite. The edges of the mesentery were accurately united close to the bowel and supported on each side by a Czerny-Lembert stitch. These were introduced from the inside in reverse order, as the proximal end could not be drawn out sufficiently (Wölfler). The ends were then brought together by tying the corresponding strands from the two rings, the pointing spots tucked in and the whole fortified by a quickly executed continuous suture. A similar suture to pucker up the mesentery belonging to the portion resected last and to unite the edges of the V-shaped portion completed the enterorrhaphy. The bowel was then carefully disinfected and replaced. The omentum, unfortunately, was not within reach, the accessible portion of the mesentery had to be excised, and as that attached to the remainder of the resection could not be sufficiently drawn out, no protective graft was applied.

The gangrenous sac was then dissected up and ligated as high as possible, the edges of the wound inverted, the cavity packed with iodoform gauze, and the sides drawn together by skin sutures.* I was led to think, from subsequent developments, that it might have been better to excise more of the sac and draw the peritonæum together.

For the notes of the after-course of the case, I am indebted to the hospital residents, Drs. Northrup and Caley.

On the third day the temperature rose to 102°; the outer dressing was removed, and the wound found in good condition. The breasts had caked and were relieved by the pump. On the following day, the temperature continuing the same, and some unhealthy pus being found, the whole wound was opened, disinfected, and loosely tamponaded. This brought the temperature down: but after another rise (103½°) wet gauze, creolinized and later carbolicized, was substituted and changed daily. The cavity filled by granulation

* McBurney, *Medical Record*, March 23, 1889.

and was firmly healed in a month. The caking of the breasts gradually subsided, and was followed on the eleventh day by an annoying parotitis. This disappeared under appropriate treatment. Flatus was passed the first night, and the distension, which increased at the beginning, soon subsided. It was followed by a cadaverous smelling diarrhoea, resembling the fluid found in the intestines. This lasted several days and gradually changed in character, until, by the fourteenth day, the stools were formed, and have continued so ever since. During the eighth night she had a number of watery stools in which the rings were probably overlooked. At the end of four weeks the bowels were thoroughly emptied by means of a mild laxative, and on the thirty-second day she was freely purged with castor oil. She went home on the thirty-sixth day apparently in the best of health, well-nourished and rapidly gaining flesh. There was but the normal general cough impulse in the inguinal regions, the scar being deep, large and firm.

The first question in this case was between an artificial anus and the restoration of the intestinal continuity. McCosh, in an able article on resection of gangrenous intestine in hernia,* gives the mortality following immediate resection and suture as 50 per cent. in one hundred and fifteen cases collected by him. These figures are a trifle below those given by other writers (Makin, Reichel, Madelung, McArdle). The closure of an artificial anus, on the other hand, gives a much lower rate, 38 per cent. (Makin, Reichel). He very justly argues, however, that to these figures must be added those who die from the kelotomy itself (20 per cent., at least), or before the fæcal fistula is closed (5 per cent.). In support of this he has collected one hundred and twenty cases, with a mortality of about 52 per cent. This figure he still considers too low, as many patients with an artificial anus are lost sight of before an attempt at cure is undertaken. The chances, then, are certainly not less in immediate union, without taking into account the future comfort of the patient. Besides, in this case, the gangrenous loop was from the small intestine, and probably far enough up the canal to cause marasmus, if fæcal fistula were made.

The next question was that of the spreading gangrene and the propriety of replacing the gut. After removing the second piece, I was satisfied, by careful observation for some time, that the intestine was perfectly healthy. It was impossible to carry out Ricchel's suggestion to fasten the gut to the thigh, well away from the wound, and wait for the line of demarcation to appear, for the proximal portion above the constriction could not have been drawn out sufficiently, even had I desired to follow his advice.

Once satisfied that a union was preferable, what method should I employ? There was no time for a circular enterorrhaphy, on account

* *New York Medical Journal*, March 15, 1889.

of the patient's condition. Lateral anastomosis, with rings or plates, aside from the objections I have already made to it, was impossible, as the proximal end could not be drawn out sufficiently. In fact, it would have been very hard to replace such a bulky mass without extensively enlarging the opening. There remained but one course open to me, *i.e.*, to unite the bowel end to end by a method both quick and safe. The rubber rings met these requirements and were accordingly used. The result certainly seems to justify their further use.

Conclusions.—1. Soft rubber drainage tubing may be used in lateral anastomoses as a substitute for bone plates, catgut rings or mats, or rubber discs. It is always at hand, and can quickly be made into rings of any required size. The tendency of these rings to assume the circular shape holds the slit open.

2. Physiological exclusion is the sphere of lateral anastomosis. When used after resections accumulations are found in the pockets; contortions occur on account of the tortuous current; adhesions are frequent and there are three lines of union to graft.

3. Well softened bone drain-rings will answer if they are at hand.

4. End-to-end union, after resection, is the ideal, and may be quickly and safely made with rubber rings or splints of soft, small drainage tubing. The region of the mesenteric attachment may be accurately united by a few catgut stitches, and eversion of the bowel edges prevented by a fine continuous suture of the same material.

5. This method is preferable to invagination, and accomplishes the same result as the Czerny-Lembert suture much more safely and quickly. The resulting constriction is barely perceptible.

6. A graft from the omentum or mesentery should be applied when practicable, the surface being first scarified.

7. Iodoform collodion prevents adhesions, and is not irritating to the peritonæum of the dog, but it also prevents plastic exudation and, therefore, union.

